6787

HALLIBURTON NUS
Environmental Corporation

copy for Jim Roberts w/ Ferrier letter J.

Environmental Technologies Group
ROCKY FLATS SOLARPOND/PONDCRETE PROJECT
452 BURBANK STREET
EG&G BUILDING 025
BROOMFIELD, COLORADO 80020
(303) 466-3573
FAX (303) 469-6354

MAR 1992
RECEIVED
Pondcrete Project

March 2, 1992

Mr. Don Ferrier
Project Manager
EG&G Rocky Flats, Inc.
5932 McIntyre Street
Golden, Colorado 80403

Subject: Design Criteria for Ponds 207A, B, & C
[WBS 431 PONDSLUDGE PROCESS TRAIN — DESIGN CRITERIA
HALLIBURTON NUS ROCKY FLATS DENVER]
RF-HED-92-0095

Dear Mr. Ferrier:

Enclosed for your approval is the design criteria basis currently being used to design both the 207 A/B and 207C Process Trains. Based on conversations with yourself and Steve Heiman on January 23, 1992 we are submitting these documents for your approval.

The design criterias have been approved by Don Brenneman of HNUS. These incorporate chemical information from the Waste Characterization Report and also geotechnical information which will be incorporated in the next revision of the report. Scheduled for submission prior to March 17, 1992.

Certain criteria for each process train incorporates processing options which HNUS is recommending which should be carefully reviewed by EG&G. These are discussed below and are segregated by each process train.

For the 207A & B processing, the A & B Series Ponds will be consolidated to make a homogenized sludge from the four ponds. The pond sludge will be dewatered at a rate of 4TPH of output filter cake. This information has been included in the inquiry document for the dewatering of the sludges to six subcontractors. This rate will generate an anticipated 6.5 TPH of final waste form. This is substantially less than was discussed in meetings in late January. HNUS recommends this rate to minimize the amount (and expense) of dewatering equipment required to mobilize to site. This processing rate should allow the A & B Series Ponds to be processed in a 45 day period on a two shift/day, 6 days/week basis.

For the 207C Pond and Clarifier processing, one waste stream for cementing will be produced consisting of a 5:1:1 ratio of water, crystals, and silt solids by weight. All treatability study and equipment design is being centered about this ratio. For this processing ratio to occur, the water level within 207C Pond must be brought back to levels observed during the sampling effort on August 22, 1991. This level was 26 inches of total material within the pond. C pond sample will be slurried using these proportions for waste formulation and treatability studies. A separate formula will be developed for a 100% water waste loading to address the final cleanup operation and solidification of <u>final</u> residues. The design criteria indicates that the Clarifier contents will be combined with the 207C Pond prior to waste processing. This will reduce the number of separate processing streams to be tested prior to processing. Currently the treatability study does not incorporate this as a requirement and will need to be incorporated if directed by EG&G.

A-OU04-000362

March 2, 1992

The current design criteria does not contain any oxidation step to remove cyanide from the Clarifier and C Pond waters. We had a conference call with Ernie Lombardi and Rich Ninesteel today to discuss that issue. Minutes of that conference call will be transmitted under separate cover for your comment. If HNUS must remove cyanide from the waters, substantial schedule impact will occur. We consider this the most critical technical issue to resolve at this time.

We request that you provide approval or comments to the design criteria by March 9, 1992. The flow sheets which were presented to you in a preliminary condition last week are being finalized this week for equipment design and final engineering design. Any changes to the design criteria after that point will have detrimental effects on the schedule.

If you have any questions, please advise.

Sincerely,

HALLIBURTON NUS ENVIRONMENTAL
CORPORATION

Ted Bittner

Ted A. Bittner
Project Manager

TAB/jg

Enclosure

cc: S. Heiman (w/o Attachments)
J. Zak
D. Brenneman
R. Ninesteel

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RF-HED-92-0095

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PROCESS DESIGN CRITERIA
PONDS 207A AND 207B

Original Signed by:
D. R. Brenneman, Vice President
Halliburton NUS Environmental Corporation
February 24, 1992

ISSUE A
2/24/92

PROCESS DESIGN CRITERIA
PONDS 207A AND 207B

1.0 GENERAL

1.0.1 Processing Rate

Product

Target Mean	9.6*	TPH
Range	3.1 - 14.0	TPH

Feed

Target Mean	2.0	TPH dry solids
Range	1.0 - 3.1	TPH dry solids

Percent Solids - Consolidated Ponds

Weighted Average	14.6%	No dilution
Reclaimed Range	5 - 15%	Estimated
Median Feed	10.0%	With dilution

Filter Cake Percent Solids - Recessed Chamber

Average Dry Filter Cake	50%	dry solids
Range Dry Filter Cake	30 - 65%	dry solids

*Note: Design capacity based on use of one 8" ϕ Teledyne Readco mixer as cement mixer. Maximum rate (@ 14.0 TPH) is limited by recessed chamber filter and casting system capacity

1.0.2 Reclaim/Dewatering System Operating Schedule

Intermittent_______ Batch_______ Continuous X

2	Shifts/Day
10	Hours/Shift (Overlapping)
6	Days/Week
67	Percent Operating Availability
12	Hours Net Operating Hours/Day

1.0.3 Cementing Operating Schedule

Intermittent_______ Batch_______ Continuous X

2	Shifts/Day
10	Hours/Shift (Overlapping)
6	Days/Week
67	Percent Operating Availability
12	Hours Net Operating Hours/Day

Note: NA = Not Analyzed
ND = Not Detected
____ = Data Not Available

1.1 POND SLUDGE CHARACTERISTICS - POND 207A

1.1.1 Cumulative Size Distribution (U.S. Standard Mesh) (1)

0.7 %	+3/8"
2.5 %	+4 m (4.75mm)
8.9 %	+10 m (2mm)
29.5 %	+100 m (147μ)
34.7 %	+200 m (74μ)
56.5 %	+400 m (38μ)
43.5 %	-400 m (-38μ)

1.1.2	Specific Gravity	1.011	Liquid	(8,9)
		1.063	Sludge	(8)
		1.482	Est. Solids	(10)
1.1.3	Estimated Volume (cubic yards)			
	Contract Scope of Work	130	Liquid	(2)
		130	Sludge	(11)
	Weston Report	572	$\text{Liquid}_{\text{TOTAL}}$	(12)
		4.2	Sludge	(12)
	JHT - 2/14/92	300	Liquid	(13)
		30	Sludge	(13)
1.1.4	Sludge Terminal Density	12.7%	% Solids	(8)
		11.2-12.7%	% Solids	(6,8)
1.1.5	Sludge Moisture (Grav.)	87.3-88.8%	% Liquid	(8)
	(Karl Fisher)	34	% Liquid	(9)
1.1.6	pH - Liquid	9.79		(9)
	- Sludge	8.9		(9)
1.1.7	Specific Conductance	9000 μmho/cm	Liquid	(9)
1.1.8	Total Dissolved Solids	7.800 gpl		(9)
1.1.9	Predominant Cations (Liquid)	Ca (0.0715 gpl)		(5)
		Mg (0.0918 gpl)		
		K (0.2560 gpl)		
		Na (1.0300 gpl)		
	(Liquid)	Ca (ND)		(9)
		Mg (0.123 gpl)		
		K (0.394 gpl)		
		Na (1.860 gpl)		

1.1.9 Predominant Cations (Continued)

(Sludge)	Mg (11,400 mg/kg)	(9)
	K (ND)	
	Na (14,500 mg/kg)	
	Cr (658 mg/kg)	
	Cd (1,300 mg/kg)	

1.1.10 Predominant Anions (Liquid)	Cl (0.400 gpl)	(9)
	CN - Total 0.43 ppm	
(Sludge)	TOC (14,000 mg/kg)	(9)
1.1.11 Sludge Viscosity	NA	
1.1.12 Sludge Liquid Limit	NA	
1.1.13 Sludge Plastic Index	NA	
1.1.14 Sludge Plastic Limit	NA	

1.2 POND SLUDGE CHARACTERISTICS - POND 207B NORTH

1.2.1 Cumulative Size Distribution (U.S. Standard Mesh) (1)

	0.3 %	+3/8"
	0.5 %	+4 m (4.75mm)
	1.3 %	+10 m (2mm)
	9.6 %	+100 m (147μ)
	16.6 %	+200 m (74μ)
	21.9 %	+400 m (38μ)
	78.1 %	-400 m (-38μ)
(Reference 8)	0.6 %	+10 m (2mm)
	8.6 %	+20 m (850μ)
	11.4 %	+40 m (425μ)
	13.5 %	+60 m (250μ)
	20.4 %	+140 m (106μ)
	23.3 %	+200 m (75μ)
	76.7 %	-200 m (75μ)

1.2.2 Specific Gravity

1.008	Liquid	(8,9)
1.175	Sludge	(8)
1.682	Est. Solids	(10)

1.2.3	Estimated Volume (cubic yards)			
	Contract Scope of Work	750	Liquid	(2)
		750	Sludge	(11)
	Weston Report	4,803	$Liquid_{TOTAL}$	(12)
		659	Sludge	(12)
	JHT - 2/14/92	2,980	Liquid	(13)
		820	Sludge	(13)
1.2.4	Sludge Terminal Density	24.9%	% Solids	(8)
		23.2-28.2%	% Solids	(6,8)
1.2.5	Sludge Moisture (Grav.)	71.8-76.8%	% Liquid	(8)
	(Karl Fisher)	25.6%	% Liquid	(9)
1.2.6	pH - Liquid	8.4		(9)
	- Sludge	7.7		
1.2.7	Specific Conductance	NA	Liquid	
1.2.8	Total Dissolved Solids	2.800 gpl		(9)
1.2.9	Predominant Cations (Liquid)	Ca (0.138 gpl)		(9)
		Mg (0.065 gpl)		
		K (0.056 gpl)		
		Na (0.296 gpl)		
	(Sludge)	Mg (3,805 mg/kg)		(9)
		Na (ND)		
		K (ND)		
		Cr (23.2 mg/kg)		
		Cd (7.1 mg/kg)		
1.2.10	Predominant Anions (Liquid)	Chloride (98 ppm)		(9)
		CN-Total (0.03 ppm)		
	(Sludge)	TOC (3,200 mg/kg)		(9)
1.2.11	Sludge Viscosity	NA		
1.2.12	Sludge Liquid Limit	72.8*		(8,9)
1.2.13	Sludge Plastic Index	37.3*		(8,9)
1.2.14	Sludge Plastic Limit	35.5*		(8,9)

* Untreated

1.3 POND SLUDGE CHARACTERISTICS - POND 207B CENTER

1.3.1 Cumulative Size Distribution			(1)
	0.1 %	+3/8"	
	0.7 %	+4 m (4.75mm)	
	7.9 %	+10 m (2mm)	
	29.0 %	+100 m (147μ)	
	31.4 %	+200 m (74μ)	
	58.1 %	+400 m (38μ)	
	41.9 %	-400 m (-38μ)	
1.3.2 Specific Gravity	1.017	Liquid	(8,9)
	1.045	Sludge	(8)
	1.348	Est. Solids	(10)
1.3.3 Estimated Volume (cubic yards)			
Contract Scope of Work	750	Liquid	(2)
	750	Sludge	(11)
Weston Report	3,631	$\text{Liquid}_{\text{TOTAL}}$	(12)
	766	Sludge	(12)
JHT - 2/14/92	780	Liquid	(13)
	820	Sludge	(13)
1.3.4 Sludge Terminal Density	8.7%	% Solids	(8)
	6.6-10.1%	% Solids	(6,8)
1.3.5 Sludge Moisture (Grav.)	89.9-93.4%	% Liquid	(8)
(Karl Fisher)	48.3%	% Liquid	(9)
1.3.6 pH - Liquid	9.1		(9)
- Sludge	9.2		
1.3.7 Specific Conductance	14,500 μmhos/cm	Liquid	(9)
1.3.8 Total Dissolved Solids	16.00 gpl		(9)
1.3.9 Predominant Cations (Liquid)	Ca (0.027 gpl)		(9)
	Mg (0.218 gpl)		
	K (0.800 gpl)		
	Na (3.150 gpl)		
(Sludge)	Mg (12,400 mg/kg)		(9)
	K (10,700 mg/kg)		
	Na (42,000 mg/kg)		
	Cr (63.1 mg/kg)		
	Cd (57.9 mg/kg)		

1.3.10	Predominant Anions (Liquid)	Chloride ND CN-Total (0.64) ppm	(9)
	(Sludge)	TOC (7,400 mg/kg)	(9)
1.3.11	Sludge Viscosity	NA	
1.3.12	Sludge Liquid Limit	82.8*	(8,9)
1.3.13	Sludge Plastic Index	28.5*	(8,9)
1.3.14	Sludge Plastic Limit	52.3*	(8,9)

* Untreated

1.4 POND SLUDGE CHARACTERISTICS - POND 207B SOUTH

1.4.1 Cumulative Size Distribution (1)

0.0 %	+3/8"
0.0 %	+4 m (4.75mm)
3.0 %	+10 m (2mm)
19.1 %	+100 m (147μ)
22.5 %	+200 m (74μ)
56.1 %	+400 m (38μ)
43.9 %	-400 m (-38μ)

1.4.2	Specific Gravity	1.019	Liquid	(8,9)
		1.065	Sludge	(8)
		1.466	Est. Solids	(10)
1.4.3	Estimated Volume (cubic yards)			
	Contract Scope of Work	745	Liquid	(2)
		745	Sludge	(11)
	Weston Report	3,611	Liquid$_{TOTAL}$	(12)
		786	Sludge	(12)
	JHT - 2/12/92	4,715	Liquid	(13)
		820	Sludge	(13)
1.4.4	Sludge Terminal Density	10.4%	% Solids	(8)
		7.9-11.7%	% Solids	(6,8)
1.4.5	Sludge Moisture (Grav.)	88.3-92.1%	% Liquid	(8)
	(Karl Fisher)	45.3%	% Liquid	(9)

1.4.6	pH - Liquid	9.07	(9)
	- Sludge	9.1	
1.4.7	Specific Conductance	17,300 µmhos/cm Liquid	(9)
1.4.8	Total Dissolved Solids	14.50 gpl	(9)
1.4.9	Predominant Cations (Liquid)	Ca (0.052 gpl)	(9)
		Mg (0.188 gpl)	
		K (0.691 gpl)	
		Na (2.360 gpl)	
	(Sludge)	Mg (10,500 mg/kg)	(9)
		Na (30,000 mg/kg)	
		Cr (38.1 mg/kg)	
		Cd (22.8 mg/kg)	
1.4.10	Predominant Anions (Liquid)	Chloride ND	(9)
		CN-Total (1.3 ppm)	
	(Sludge)	TOC (8,600 mg/kg)	(9)
1.4.11	Sludge Viscosity	NA	
1.4.12	Sludge Liquid Limit	NA	
1.4.13	Sludge Plastic Index	NA	
1.4.14	Sludge Plastic Limit	NA	

1.5 **POND SLUDGE CHARACTERISTICS - COMBINED 207A & 207B PONDS**
(Weighted Average Values) (10)

1.5.1 Cumulative Size Distribution (1)

0.2 %	+3/8"
0.6 %	+4 m (4.75mm)
3.4 %	+10 m (2mm)
16.7 %	+100 m (147µ)
21.9 %	+200 m (74µ)
39.0 %	+400 m (38µ)
61.0 %	-400 m (-38µ)

1.5.2 Specific Gravity

1.015	Liquid	(8,9)
1.100	Sludge	(8)
1.569	Est. Solids	(10)

1.5.3	Estimated Volume (cubic yards)			
	Contract Scope of Work	2,375	Liquid	(2)
		2,375	Sludge	(11)
	Weston Report	12,618	$Liquid_{TOTAL}$	(12)
		2,215	Sludge	(12)
	JHT - 2/14/92	8,775	Liquid	(13)
		2,490	Sludge	(13)
1.5.4	Sludge Terminal Density	14.6%	% Solids	(8)
		6.6-28.2%	% Solids	(6,8)
1.5.5	Sludge Moisture (Grav.)	71.8-93.4%	% Liquid	(8)
	(Karl Fisher)	39.4%	% Liquid	(10)
1.5.6	Sludge Viscosity	NA		

1.6 **POND RECLAIM SYSTEM**
(Note: Sub-contractor Scope. Criteria provided as guidelines for interfacing with downstream stabilization processing.)

1.6.1 Maximum Particle Size Reclaimed 1-1½ inch

1.6.2 Nominal Reclaim Rate 100 - 400 gpm

1.6.3 Particle Size Cut Point in Scalping Screen 10 mesh

1.6.4 Responsibility For Pond Oversize Removal EG&G

1.6.5 Responsibility For Pond Cleaning EG&G

1.6.6 Responsibility For Screen Oversize EG&G

1.6.7 Reclaim System To Be X Leased
_____ Purchased

1.6.8 Reclaim System Type Responsibility of Sub-Contr.

1.6.9 Estimated Reclaim Slurry Density 10 % Solids

1.6.10 Estimated Sludge Specific Gravity 1.065
(For Estimated Average Solids S.G. = 1.569)

1.7 **SIZE LIMITATION**
(Note: Sub-contractor Scope. Criteria provided as guidelines for interfacing with downstream stabilization processing.)

1.7.1 Particle Size Requirements to Cementing Operation

100% Passing 10 U.S. mesh or 2000 microns
80% Max. Passing 400 mesh or 38 microns

1.7.2 Particle Size Limit To Filtration
100% Passing 10 U.S. mesh or 0.078 inch

1.7.3 Oversize From Screen Scalping To half crate box

1.8 **POND CONSOLIDATION/GRAVITY SETTLING**
(Note: Sub-contractor Scope)

1.8.1 Additions Prior To Filtration Hydrated Lime to pH = 10.5 - 11.0
Estimated: 12.0 lbs/ton slurry @10% solids feed

Calcium Hypochlorite For L/S Separation Improvement and Pathogenic Treatment 20lbs/ton* dry solids in feed

*Note: @ 10% solids in feed, 20 lbs/ton dry solids is equivalent to 1000 ppm of 65% calcium hypochlorite added to slurry (2.0 lbs/ton slurry). This is consistent with maintaining a minimum of 2.0 ppm free chlorine for 30 minutes.

1.8.2 Flocculant Type Very High Charge Cationic Polyacrylamide by Stockhausen & CIE PRAESTOL 644BC or equivalent

*Note: Flocculant listed is typical, included as an example only.

1.8.3 Flocculant Dosage 10-20 lbs/ton solids @ 0.1% Soln.

1.8.4 Sludge Consolidated in 207B South Pond*

*Note: Additions made to initial 207C pond contents by reclaim and circulation prior to consolidation and addition of contents of other ponds.

1.8.5 Decant Consolidated in 207B North Pond

1.9 DEWATERING PRESSURE FILTER

(Note: Sub-contractor Scope. Criteria provided as guidelines for interfacing with downstream stabilization processing. Assumptions based on utilization of recessed chamber or diaphragm pressure filter.)

1.9.1 Pressure Filter Feed Rate (GPM feed @ 10% solids)

Nominal: 165 gpm
Range: 145 - 185 gpm

1.9.2 Filter Cake

Nominal: 60.0 % Solids
Range: 40 - 65 % Solids

1.9.3 Design Basis (@ 60% solids cake) 2.0 lbs dry solids/hr/ft^2

Range: 1.0 - 3.0 lbs/hr/ft^2

1.9.4 Flocculant Used (Coagulant) X YES ____ NO

1.9.5 Flocculant Type (Coagulant) High Charge Cationic Quaternary Amine - American Cyanamid's Magnafloc™ 581C*

*Note: Flocculant listed is typical, included as an example only.

1.9.6 Flocculant Dosage (Coagulant) 15 lbs/ton solids @ 10% Solution

1.9.7 Lime (Hydrated) Added Prior To Filtration (Optional)

*Note: All lime required for stabilization mix may be added prior to filtration to improve filtration rate and soften filtrate. Based on 8.0% lime added to total stabilized waste minus available lime in flyash (equivalent to 5.18% of flyash weight), additional lime which would be added in cementing:

30% Solids Filter Cake	1,055 lbs lime/ton solids
50% Solids Filter Cake	546 lbs lime/ton solids
60% Solids Filter Cake	419 lbs lime/ton solids

1.9.7 Cake Discharge/Surge Hopper Residence Time

2 hours product (@ 50% solids)
(≈200 cubic foot capacity)

1.9.8	Size Of Broken Cake	Nominal 1" X 2" or Smaller (Suitable for conveyor transport)
1.9.9	Filter Cycle Time	One cycle/filter every two hours based on two ≈90 cubic foot capacity filter.

1.10 CEMENTING AND CASTING

1.10.1	Feed Holding/Surge Residence Time	2 hours product (@ 50% solids) (≈200 cubic foot capacity)
1.10.2	Feed Surge Mixer (Blender) Residence Time	Nominal 20 minutes (@ 50% solids filter cake - ≈ 57 cubic foot capacity)
1.10.3	Cement Mixer Type	Low-Residence-Time, High-Intensity Continuous Mixer (e.g. Teledyne Readco 8"ϕ)
1.10.4	pH Requirements	10.5-11.5 Precementing 12.2+ Cementing
1.10.5	pH Adjusted With	Hydrated Lime Note: 8.0 wt.% net Lime added to Stabilized Mix (see Section 1.9.7) in blender (surge hopper).
1.10.6	Other Additives	
	Precementing	Viscosity Modifier (Optional)
	Surge Hopper	Fly Ash Type C

1.10.7 Cementing Stabilization Parameters (14)
(Treating dry solids as aggregate, Target Feed: 50% solids cake, Range: 30-65% solids cake)

Pond Liquid	0.5 PARTS	21.2%	Mean
	1.0-0.35	35.0-100%	Range
Pond Solids (DRY)	0.5 PARTS	21.2%	Mean
	0.0-0.65	0.0-65.0%	Range
Cement TYPE V	0.40 PARTS	16.8%	Mean
	0.28-0.79	14.0-22.0%	Range
Fly Ash TYPE C	0.80 PARTS	33.7%	Mean
	0.55-1.59	28.0-44.1%	Range
Total Hydrated Lime	0.17 PARTS	7.1%	Mean
	0.15-0.22	6.1-7.6%	Range

*Note: Based on Free Water/(Cement+Flyash) = 0.42

1.10.8 Other Characteristics of Cement Waste Form

Slump (inches)	0-1		
Cast in ½ Crates	YES	X	NO
If NO, How?	Pellet or Briquette deposited in half crate		
Pressure Pumpable?	YES	X	NO
Strength (psi)	600+ Target		
@Time =	28	28	days
Method	UCS	UCS	
Maximum Temperature	150°F in halfcrate		
Other	Pass paint filter test DOT 4359-84 Paint Can Test Two ½-gallon containers sample per waste form batch.		

1.10.9 Casting System Requirements

- Product discharge must be interruptable to move container.
- Require casting as pellets or extrusions.
- Produce high-density packing in container.
- Needs casting weight and operating documents to accompany waste form.
- Final certification weight by EG&G.

1.11 EQUIPMENT LOCATION

1.11.1 Pond Consolidation System
Located on West side of 207B South between 207A pond and 207B ponds.

1.11.2 Pond Reclaim System
Located within pond berm area and on West side of 207B South between 207A pond and 207B ponds. Pump to size limitation and pretreatment (chlorination and polymer addition) before dewatering or during pond consolidation.

1.11.3 Size Limitation and Pretreatment
Located on West side of 207B South between 207A pond and 207B ponds.

1.11.4 Dewatering
Located South of 207A and SW of 207B ponds.

1.11.5 Cementing
Located South of 207A and SW of 207B ponds. Product of mixer discharges into pelletizer or briquetter prior to casting station.

1.11.6 Casting
Enclosed structure with HEPA filtration system capable of supporting 14.0 tph product.

1.12 OTHER CONSIDERATIONS

Prior to transport to 750 pad, container lid must be set on half crate container, fiber-glass cover set over container lid and composite container secured with strapping.

Cementing equipment to be relocated to 904 pad for use with Pondcrete/Saltcrete. Thus, capacity of all feeders and equipment capable of handling 14.0 tph maximum product rate.

2.0 REFERENCES

(1) Based on Weston Memo, M. E. Selman to T. Bittner, July 16, 1991, Excerpts From Pond Sludge Sampling Report, Issued July, 1991

(2) Statement of Work, Solar Ponds and Pondcrete, April 16, 1991 (Revision: October 14, 1991)

(3) Assumption as per D. R. Brenneman, Halliburton NUS Environmental Corporation

(4) Weston Health & Safety Plan, Sampling Solar Pond Water, Sludge, and Sediment, April 1991

(5) NUS Draft Waste Sampling Plan, Received June 5. 1991)

(6) Weston, Pond Sludge Sampling Report, Issued, July, 1991

(7) HNUS Pittsburgh, Technical Memo, Treatability Testing Performed at Halliburton NUS Laboratory, Pittsburgh, Pennsylvania, December, 1991

(8) Memo of Pond Sludge Characterization Data, November 14, 1991, HNUS, Pittsburgh

(9) HNUS Pittsburgh, Pond Sludge and Clarifier Sludge Waste Characterization Report, Deliverables 224A and 224E Combined, Draft Issued January, 1992

(10) B&R Houston IOM, Suggested Pond 207A&B Composite Mix Ratios, January 10, 1992

(11) HNUS, Special Conditions Report, Revision 3, November 7, 1991

(12) Table 2: Estimated Quantities From Weston Report Data, Pond Sludge Design Basis Memo, August 26, 1991

(13) Amendment I, February 12, 1992, Request For Proposal - Stage 1 Densification, Subcontractor Scope Of Work, Attachment 2 (By JHT, 2/12/92)

(14) HNUS FAX, SM to TB, February 21, 1992, Stabilization Mix Recipes - Second Cut

Signed: D R Brenneman

Original Signed By:
D. R. Brenneman, Vice President
Halliburton NUS Environmental Corporation

Date: 2/24/92

PROCESS DESIGN CRITERIA
POND 207C AND CLARIFIER SLUDGE

Original Signed by:
D. R. Brenneman, Vice President
Halliburton NUS Environmental Corporation
February 24, 1992

ISSUE A
2/24/92

PROCESS DESIGN CRITERIA
PONDS 207C AND CLARIFIER SLUDGE

1.0 **GENERAL**

1.0.1 Processing Rate

Product

Target Mean 14.0* TPH
Range 7.0 - 18.5 TPH

Feed (22)

Target Mean 0.985 TPH dry** solids
Range 0.00 - 2.28 TPH dry** solids

Percent Solids 16.2% Median
0.0 - 32.0% Range

Total Rate 6.23 STPH Slurry Feed
17.0 GPM Slurry Flow

*Note: Design capacity based on one 8"ϕ Teledyne Readco mixer.

**Note: Assumption is that pond 207C level maintained at 26" depth consistent with condition of pond on August 22, 1991 (Reference 20: JHT to WCH, February 21, 1992). This is equivalent to pond slope linear measurement of 185" at reference point. This gives approximate volume ratio of brine:salt:silt of 5:1:1 which has resulted in a successful stabilized waste form (cement/flyash/lime) (Reference 21: SM to TB, 2/21/94). The 207C pond consists of dry salt crystals and inert solids, dry basis.

Note: NA = Not Analyzed
ND = Not Detected
_____ = Data Not Available

1.0.2 Pond 207C Physical Material Characteristics (14,16)
(Note: Based on References 14, 16 and 21)

Salt Crystals		
Percent of Pond Feed	16.0%	Weight %
Water of Hydration	58.2%	Weight %
Dry Salt	41.8%	Weight %
Silt (Settled Sludge Slurry)		
Percent of Pond Feed	16.0%	Weight %
Inert Solids	59.2%	Weight %
Liquid (Water+Salt)	40.8%	Weight %
Pond Liquid Phase (Brine)		
Percent of Pond Feed	68.0%	Weight %
Water	54.0%	Weight %
Salt (Dissolved)	46.0%	Weight %
Free Water In Pond	45.3%	Weight %
Solid Salt In Pond	6.7%	Weight %
TDS Salt In Pond	38.6%	Weight %
Silt Inerts In Pond	9.4%	Weight %

1.0.3 Reclaim/Milling System Operating Schedule

Intermittent______ Batch______ Continuous X

2	Shifts/Day
10	Hours/Shift (Overlapping)
6	Days/Week
67	Percent Operating Availability
12	Net Nominal Operating Hours/Day

1.0.4 Cementing Operating Schedule

Intermittent______ Batch______ Continuous X

2	Shifts/Day
10	Hours/Shift (Overlapping)
6	Days/Week
67	Percent Operating Availability
12	Net Nominal Operating Hours/Day

1.1 POND SLUDGE CHARACTERISTICS - POND 207C

1.1.1 Cumulative Size Distribution (U.S. Standard Mesh) (1)

Salt Crystals Only

13.2 %	+3/8"
48.1 %	+4 m (4.75mm)
89.8 %	+10 m (2mm)
99.1 %	+100 m (147μ)
99.1 %	+200 m (74μ)
99.1 %	+400 m (38μ)
0.9 %	-400 m (-38μ)

1.1.2 Specific Gravity

1.332	Liquid	(8,9)
1.316 - 1.348	Range	
1.613	Sludge (30%)	(12)
2.256	Dry Salt*	(12)
2.077	Hydr. Salt*	(12)

*Note: Crystalline salt (dry) assumed to contain 16.6% water based on EG&G Building 374 data.

Recent data for "Salt Mush" (16)

Total Water	58.2%	Weight % Liquid
Total Dry Salt	41.8%	Weight % Solids
Slurry S.G.	1.43	

Calculated S.G. Salt	2.029	Using water	(17)
	1.566	Using brine	(17)

Recent data for "Silty Solids" (16)

Total Water	40.8%	Weight % Liquid
Total Dry Salt	59.2%	Weight % Solids
Slurry S.G.	1.46	

Calculated S.G. Salt	1.777	Using water	(17)
	1.548	Using brine	(17)

1.1.3 Est. Current Volume (cubic yards)

Contract Scope of Work		745	Liquid	(2)
		745	Sludge	(11)
Weston Report		916	Liquid	(13)
		956	Sludge	(13)
JHT - 2/14/92		560	Liquid	(19)
		1450	Sludge	(19)
JHT - 8/22/91	≈5.0	1,551	Liquid	(20)
	≈1.0	314	Silt Slurry	(20)
	≈1.0	322	Salt Crystals	(20)

1.1.4	Sludge Terminal Density	60.5% % Solids	(8)
	(In Lab Sample of Salt)	51.6 - 65.2% % Solids	(8)
1.1.5	Sludge Moisture (Karl Fisher)	NA % Liquid	(9)
1.1.6	pH - Liquid	10.08	(8)
	- Sludge	10.47	
1.1.7	Specific Conductance (Liquid)	>50,000 µmho/cm	(9)
		51,000 µmho/cm	(18)
1.1.8	Total Dissolved Solids	460.0 gpl	(9)
		300-510 gpl Range	
		400.0 gpl	(6)
1.1.9	Predominant Cations (Liquid)	Ca (>0.200 gpl)	(6)
		B (0.3600 gpl)	
		K (78.700 gpl)	
		Na (102.00 gpl)	
	(Liquid)	Ca (ND)	(9)
		B (0.463 gpl)	
		K (5.580 %)	
		Na (13.80 %)	
	(Sludge)	Mg (3,370 mg/kg)	(9)
		Na (157,600 mg/kg)	
		Cr (618 mg/kg)	
		Cd (164 mg/kg)	
1.1.10	Predominant Anions (Liquid)	Cl (0.023 gpl)	(9)
		CN-Total (7.7 ppm)	
	(Sludge)	Cl NA	(9)
		CN-Total (72 ppm)	
		TOC (7,700 mg/kg)	
1.1.11	Sludge Viscosity	NA	
1.1.12	Sludge Liquid Limit	NA	
1.1.13	Sludge Plastic Index	NA	
1.1.14	Sludge Plastic Limit	NA	

1.2 **CLARIFIER SLUDGE CHARACTERISTICS***
(*Note: Assumption is that clarifier sludge and liquid will be introduced into 207C as a slurry pond prior to processing.)

1.2.1 Cumulative Size Distribution (U.S. Standard Mesh)

______ %	+3/8"	
______ %	+4 m	(4.75mm)
______ %	+10 m	(2mm)
______ %	+100 m	(147μ)
______ %	+200 m	(74μ)
______ %	+400 m	(38μ)
______ %	-400 m	(-38μ)

1.2.2	Specific Gravity	______	Liquid	
		______	Sludge	
		______	Est. Solids	
1.2.3	Est. Current Volume (Gallons)	20,000	Liquid	(3)
		5,000	Sludge	
1.2.4	Sludge Terminal Density	39.4	% Solids	(9)
		27.5-66.9	% Solids	(9)
1.2.5	Sludge Moisture (Grav.)	60.6	% Liquid	
	(Karl Fisher)	______	% Free Liquid	
1.2.6	pH - Liquid	10.0		(9)
	- Sludge	9.75		
1.2.7	Specific Conductance (Liquid)	34,500 μmho/cm		(9)
1.2.8	Total Dissolved Solids	59.00 gpl		(9)
1.2.9	Predominant Cations (Liquid)	Ca (ND)		(9)
		Mg (0.004 gpl)		
		K (0.057 gpl)		
		Na (0.012 gpl)		
		B (0.028 gpl)		
	(Sludge)	Mg (20,500 mg/kg)		(9)
		Na (78,000 mg/kg)		
		K (56,900 mg/kg)		
		Cr (2,480 mg/kg)		
		Cd (3,660 mg/kg)		
		Ni (700 mg/kg)		
		Ag (135 mg/kg)		
		CN Total 87 ppm		

1.2.10 Predominant Anions (Liquid) — Chloride (2.09 gpl) (9); CN-Total (2.7 ppm)

(Sludge) — TOC (5,175 mg/kg) (~~9~~)

1.2.11 Sludge Viscosity ____________

1.2.12 Sludge Liquid Limit ____________

1.2.13 Sludge Plastic Index ____________

1.2.14 Sludge Plastic Limit ____________

1.3 207C POND RECLAIM SYSTEM

1.3.1 Maximum Particle Size Reclaimed — 2.0 inch

1.3.2 Nominal Reclaim Rate — 100 - 400 gpm

1.3.3 Nominal Brine Slurry Processing Rate — 14.9 gpm (15)

1.3.4 Responsibility For Pond Oversize Removal — EG&G

1.3.5 Responsibility For Pond Cleaning — EG&G

1.3.6 Reclaim System To Be — X Leased; ______ Purchased

1.3.7 Reclaim System Type — Hydraulic adjustment of the ratio of solids to liquid to conform to treatability study results (Pond 207C conditions of 8/22/91). Vacuum-assisted suction pumping system used.

1.3.8 Estimated Reclaim Slurry Density — 16.2% Solids
Range: 0-20% Solids

1.3.9 Estimated Sludge Specific Gravity (For Solids S.G. = 2.077) — 1.613

1.4 POND 207C SIZE REDUCTION

1.4.1 Particle Size Requirements to Cementing Operation

100% Passing 10 U.S. mesh or 2000 microns
80% Max. Passing 400 mesh or 38 microns

1.4.2 Particle Size Limit To Pin Mill
100% Passing 1½ inch

1.4.3 Additions Prior To Transport* Hydrated Lime to pH = 10.5 - 11.0
Estimated ≈ 20 lbs/ton slurry @16.2% solids

Calcium Hypochlorite for Pathogenic Treatment
20 lbs/ton slurry

*Note: @16.2% Net dry solids in feed brine slurry, 20 lb/ton slurry of 65% calcium hypochlorite is equivalent to 1000 ppm added to slurry. This is consistent with sustaining a minimum 2.0 ppm free chlorine residual in solution after 30 minutes. Equipment required for calcium hypochlorite addition to be leased from reclaim system operator.

1.5 CLARIFIER SLUDGE RECLAIM SYSTEM

1.5.1 Reclaim System Type Vacuum-Assisted Pump* and Existing Diaphragm U/F pumps used to transfer clarifier sludge to 207C pond to commingle for processing.

*Note: Leased unit

1.6 CEMENTING AND CASTING

1.6.1 Feed Holding or Surge Capacity 30 Minutes
Minimum at 14 TPH Product Rate

1.6.2 Cement Mixer Type Low-Residence-Time, High-Intensity Continuous Mixer (e.g. 8"ϕ Teledyne Readco)

1.6.3 pH Requirements 10.5-11.5 Precementing
12.2+ Cementing

1.6.4 pH Adjusted With Hydrated Lime

1.6.5 Other Additives

Precementing	None ($FeSO_4$ optional)
	Hydrated Lime added @ 8% of stabilization mix weight

Brine treatment only:	0.141 tons lime/ton soln.
Pond Level of 8/22/91:	0.137 tons lime/ton slurry
Pond Level of 11/13/91:	0.139 tons lime/ton slurry

Cementing	Viscosity Modifier (Optional)
	Fly Ash Type C (S.G. = 2.74)
	Cement Type V (S.G. = 3.17)
	See below

1.6.6 Cementing Stabilization Parameters - Pond 207C (21)
(Note: Free Water/(Cement+Flyash) = 0.420)

Target Mid-Point:	Pond Condition of 8/22/91	(20)
Target Low:	Brine only	
Target High:	Pond Condition of 11/13/91	(20)

Pond Liquid	0.680	PARTS	30.3%	Mean
	0.30-1.00	PARTS	14.7-40.7%	Range
Pond Salt Mush	0.160	PARTS	7.1%	Mean
	0.00-0.20	PARTS	0.0- 9.8%	Range
Pond Silt Slurry	0.160	PARTS	7.1%	Mean
	0.00-0.51	PARTS	0.0-25.0%	Range
Cement TYPE V	0.358	PARTS	16.0%	Mean
	0.29-0.43	PARTS	14.3-17.4%	Range
Fly Ash Type C	0.718	PARTS	32.0%	Mean
	0.58-0.86	PARTS	28.5-34.9%	Range
Hydrated Lime	0.167	PARTS	7.4%	Mean
(Total)	0.16-0.17	PARTS	6.9-8.4%	Range

1.6.7 Cementing Stabilization Parameters - Clarifier (20)
(Note: The assumption is that clarifier sludge will be combined and mixed with 207C contents. At 25,000 gallons versus 450,000+ gallons in 207C pond, the mix would contain slightly over 5% of the clarifier sludge; thus would have the properties of 207C alone.)

1.6.8 Other Characteristics of Cement Waste Form

Slump	11-12"		inches
Cast in ½ Crates	X	YES	NO
If NO, How?			
Pressure Pumpable?	X	YES	NO
Hardness (psig)	600+ Target		
@Time =	28	28	days
Method	UCS	UCS	
Maximum Temperature	150°F in halfcrate		
Other	Pass paint filter test DOT 4359-84 Paint Can Test Two ½-gallon container sample per waste form batch		

1.6.9 Casting System Requirements

- Recipe is envisioned to be a liquid.
- Special splash protection during pouring needs to be integrated into the design.
- Initial set time estimated to be 30 minutes.
- Other criteria similar to ponds A&B.
- Needs casting weight and operating documents to accompany waste form.
- Final certification weight by EG&G.
- Shroud over half crate may be required during pouring to improve containment.

1.6.10 Holding Station

- Needs to hold filled half crates for 30 minutes to set sufficiently to be moved.
- Moved to 750 pad for curing after inspection and initial set.

1.7 EQUIPMENT LOCATION

1.7.1 Pond Reclaim System

- Located within or adjacent to pond berm area at SW end of 207C pond.
- Includes pump to size reduction (Pin Mill) and before transport to pretreatment and cementing.

1.7.2 Size Reduction

- Delumper, overflow head tank and pin mill are located South or SW of 207C pond.
- Transport pipeline from pin mill sump to first pretreatment tank located South of 207A pond.

1.7.3 Pretreatment

- First pretreatment tank where calcium hypochlorite and $FeSO_4$ (if needed) are added is a gravity-overflow agitated tank (one of two in series). It is located South of 207A pond and also serves as receiving/surge tank.
- The second pretreatment tank is where the lime for pH adjustment and additional lime required for the stabilization mix is added. It is added as a solid powder and is mixed in the tank. The tank is pumped from the bottom and circulated.
- Slurry feed to the cementing is controlled on the recycle stream.

1.7.4 Cementing

- Located South of 207A and SW of 207B ponds.
- Product of mixer discharges into half crates in casting station.

1.7.5 Casting

- Located South of 207A pond at end of cementing train.

1.8 OTHER CONSIDERATIONS

- Same as those for A&B train except that most of this equipment (possibly the $FeSO_4$ and calcium hypochlorite systems and surge tanks) will not be used on the 904 pad.

2.0 REFERENCES

(1) Based on Weston Memo, M. E. Selman to T. Bittner, July 16, 1991, Excerpts From Pond Sludge Sampling Report, Issued July, 1991

(2) Statement of Work, Solar Ponds and Pondcrete, April 16, 1991 (Revision: October 14, 1991)

(3) Assumption as per DRB, H/NUSEC

(4) Weston Health & Safety Plan, Sampling Solar Pond Water, Sludge, and Sediment, April 1991

(5) NUS Draft Waste Sampling Plan, Received June 5. 1991)

(6) Weston, Pond Sludge Sampling Report, Issued, July, 1991

(7) HNUS Pittsburgh, Technical Memo, Treatability Testing Performed at Halliburton NUS Laboratory, Pittsburgh, Pennsylvania, December, 1991

(8) Memo of Pond Sludge Characterization Data, November 14, 1991, HNUS, Pittsburgh

(9) HNUS Pittsburgh, Pond Sludge and Clarifier Sludge Waste Characterization Report, Deliverables 224A and 224E Combined, Draft Issued January, 1992

(10) B&R Houston IOM, Suggested Pond 207A&B Composite Mix Ratios, January 10, 1992

(11) HNUS, Special Conditions Report, Revision 3, November 7, 1991

(12) Table 6a: Process Inputs to Pure Salt Processing (POND 207C), Saltcrete DBM, November 11, 1991, Revision a, 1/27/92

(13) Table 2: Estimated Quantities From Weston Report Data, Pond Sludge DBM, August 26, 1991, (Based on information supplied to TB by JG, EG&G, June 1991 and pond volume calculations by JHT, July 1991)

(14) HNUS Memo, SM to DRB, January 29, 1992, Preliminary Design Information

(15) B&R Memo, WCH to JRZ, February 6, 1992, Material Balances For Pond Sludge Processing - Revision 5a, Plan B For Ponds 207A&B and Plan C For Pond 207C And Clarifier Using Mix Formulations and Assumptions of Memo: SM to DRB, 1/29/92, (i.e. Reference 14)

(16) HNUS, FAX RMN to TB, February 12, 1992, 207C Starting Mix Calculation

(17) B&R Memo, WCH to JRZ, February 17, 1992, Interpretations Of Recent Mixture Data Supplied By HNUS (RMN to TB, 2/12/92)

(18) HNUS Memo, SM to DRB, February 10, 1992, Treatability Studies Status Report (Week of Feb. 3-7, 1992)

(19) Amendment I, February 12, 1992, Request For Proposal - Stage 1 Densification, Subcontractor Scope Of Work, Attachment 2 (By JHT, 2/12/92)

(20) B&R Memo, JHT to WCH, February 21, 1992, Volume of Solids and Solution in the 207C Pond

(21) HNUS FAX, SM to TB, February 21, 1992, Stabilization Mix Recipes - Second Cut

(22) B&R Memo, WCH to JRZ, February 24, 1992, Material Balance Revision 6 - Equivalent Material Balances for 207A&B and 207C Pond & Clarifier For Design Criteria, Issue 0

Signed: D R Brenneman

Original Signed By:
D. R. Brenneman, Vice President
Halliburton NUS Environmental Corporation

Date: 2/24/92